

HAMAMATSU

TECHNICAL DATA SHEET

R647 SERIES

PHOTOMULTIPLIER TUBE

½ INCH DIA.

- R647 (For Spectroscopy)
- R647-01 (For Scintillation Counting and High Energy Physics)
- R647-02 (For Computed Tomography)
- R647-04 (For Photon Counting)

Bialkali Photocathode, 1/2 Inch (13 mm) Diameter, 10 Stage Line Type Dynodes, Head-on Type Photomultiplier.

MAXIMUM RATINGS (Absolute Maximum Values)

Supply Voltage

between Anode and Cathode. 1250 Vdc

between Anode and Dynode No. 10 250 Vdc

Average Anode Current (Note 1). 0.1 mA

Average Cathode Current (Note 2) 50 nA

Ambient Temperature. -80 ~ + 50° C

Shock 30G

Vibration (less than 500 Hz) 10G

GENERAL DATA

Spectral Response 300 ~ 650 nm (See Fig. 1)

Wavelength of Maximum Response approx. 420 ± 30 nm

Photocathode Material Bialkali

Useful Photocathode Area. 9 mm Dia. min.

Dynode Material Alkali-Antimonide

Dynode Construction Line Type

Direct Interelectrode Capacitances (approx.)

Anode to Dynode No. 10 1.0 pF

Anode to All Other Electrodes 2.0 pF

Window

Material. Borosilicate Glass

Index of Refraction at 420 nm 1.50 ± 0.01

Faceplate Flatness. Less than ± 50 μm

Shape Plano-Plano

Operating Position. Any

Net Weight

R647, R647-01 9 g

R647-02 9.5 g

R647-04 15 g

Base. 13 Pin Glass Base

Socket. HTV E678-13A

Socket Assemblies. HTV E849 series

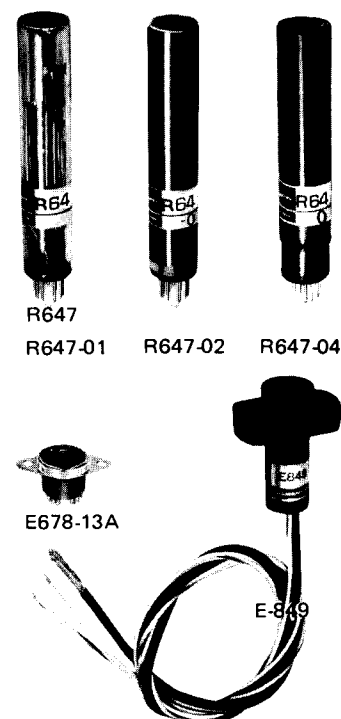
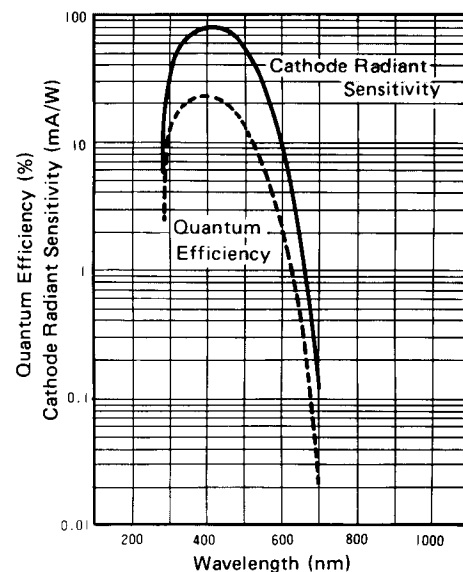


Fig. 1 Spectral Response



CHARACTERISTICS

ITEM	R 647			R647-01			R647-02			R647-04			Units
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Anode Luminous Sensitivity (note 3,4)	30	80		30	80		5	60		70	200		A/ℓm
Anode Blue Sensitivity with 5-58 (note 3,5)					10.0								A/ℓm blue
Anode Blue Sensitivity with 4-72 (note 3,6)							1.8	21					A/ℓm blue
Quantum Efficiency at 420 nm		20		15	23			20			23		%
Quantum Efficiency at 480 nm							10	13					%
Cathode Luminous Sensitivity (note 7)	40	70		60	80		40	70		60	80		μA/ℓm
Cathode Blue Sensitivity with 5-58 (note 8)	5.0	8.8		7.5	10			8.8		7.5	10		μA/ℓm blue
Cathode Blue Sensitivity with 4-72 (note 9)							14	24.5					μA/ℓm blue
Current Amplification (note 3)		1.1x10 ⁶			1.0x10 ⁶			0.9x10 ⁵			25x10 ⁶		
Anode DC Dark Current (note 3)		5	15		1	5		1	5		5	15	nA
Background Noise above 5.9 keV					10	60							cpm
Dark Counts above H _v (See Fig. 7)											80	400	cps
Anode DC Current Stability (note 3,10)		6						6					%
Long Term Stability (note 3,11a)					6								%
Short Term Stability (note 3, 11b)					6								%
Pulse Height Resolution with ¹³⁷ Cs (note 3,12)					8.5								%
Pulse Height Resolution with ⁵⁷ Co (note 3,13)					16								%
DC Linearity from 50 nA to 50 μA (note 14)								2.5	5				%
Anode Current Rise Time (note 3, 15)		3.2			3.2			3.2			3.2		ns
Electron Transit Time (note 3,16)		30			30			30			30		ns

NOTES

1. Averaged over any interval of 30 seconds maximum.
2. Same as note 1 and the whole photocathode is illuminated.
3. Voltage distribution ratio;
K: Cathode Dy: Dynode P: Anode
Supply Voltage = 1,000volts

electrode	K	DY ₁	DY ₂	DY ₃	DY ₄	DY ₅	DY ₆	DY ₇	DY ₈	DY ₉	DY ₁₀	P
distribution ratio	1	1	1	1	1	1	1	1	1	1	1	1

4. The light source is a tungsten filament lamp operated at a distribution temperature of 2856 K. The light input of 10⁻⁷ lumen is used. The load resistor has a value of 10 kilo-ohms.
5. The value is anode sensitivity when the blue filter (Corning CS No. 5-58 polished to 1/2 stock thickness) is interposed between the light source (providing 10⁻⁷ lumen) and the tube under the same condition as note 3.
6. The condition is the same as note 5 except the blue filter (Corning CS No. 4-72 of full stock thickness).
7. The condition is the same as note 4 except that the value of light input is 10⁻⁴ lumen and 150 volts are applied between cathode and all other electrodes connected together as anode.
8. The value is cathode sensitivity when the blue filter (Corning CS No. 5-58 polished to 1/2 stock thickness) is interposed between the light source (providing 10⁻⁴ lumen) and the tube under the same condition as note 7.
9. The condition is the same as note 8 except the blue filter (Corning CS No. 4-72 of full stock thickness).
10. The value is a period of 8 hours after 1 hour of warm-up with anode current of 10 micro-amperes.
11. A ¹³⁷Cs source and an NaI (TI) crystal are employed to measure the pulse height. Scintillator (NaI (TI) crystal) is 1/2" diameter and 1/2" thickness. Warming-up is about 1 hour.

- a) Long Term Stability (Mean Gain Deviation);
Defined as follows

$$Dg = \frac{\sum_{i=1}^n |P - P_i|}{n} \cdot \frac{100}{P} (\%)$$

Where P is the mean pulse height averaged over n readings. P_i is the pulse height at n-th reading, and n is total number of readings.

- b) Short Term Stability;
The Photomultiplier Tube is first operated at about 1,000 cps. The photopeak count is then decreased approximately 200 cps by increasing the distance between source and crystal on the tube.
12. Scintillator is manufactured by Quartz & Silice (Type SP14X25, NaI (TI), 1/2" diameter and 1" thickness). Photopeak count rate is 200 cps.
13. Scintillator is manufactured HARSHAW CHEMICAL (Type 2D2, NaI (TI), 1/2" diameter and 1/2" thickness). Photopeak count rate is 200 cps.
14. DC linearity is defined as the deviation of anode output current from an ideal straight line. Test condition is as follows:
light source : tungsten lamp + blue filter (CS No. 4-72)
dynode string : E849-17 (See Fig. 9 (b))
It is recommended that the voltage between Dy9 and Dy 10 shall be maintained constant by voltage clamping, and aslo all the resistors shall be kept lower as possible as you can.
15. The rise time is the time for the output pulse to rise from 10% to 90% of the peak output when the tube is illuminated by a flash of light of very short duration. In measurement, the whole photocathode is illuminated.
16. The electron transit time is the interval between the arrival of delta function light pulse at the entrance window of the tube and the time when the output pulse at the anode terminal reaches peak amplitude. In measurement, the whole photocathode is illuminated.

Fig. 2 Anode Sensitivity and Amplification Characteristics (R647-01)

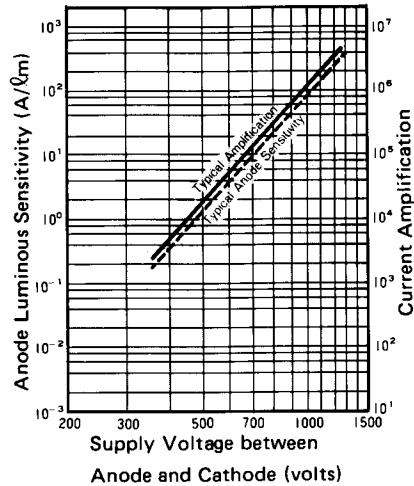


Fig. 3 Time Resolution

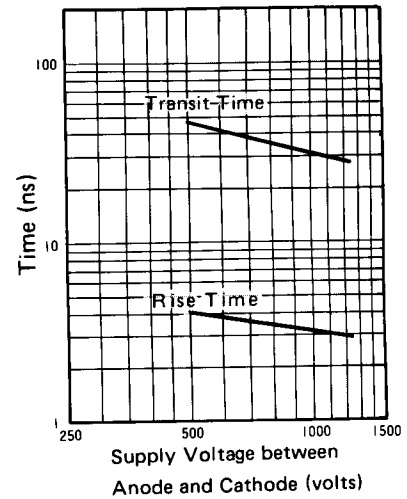


Fig. 4 Effect of Magnetic Field

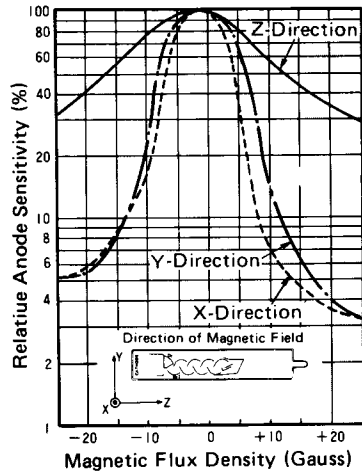


Fig. 5 Temperature Characteristics on Sensitivity

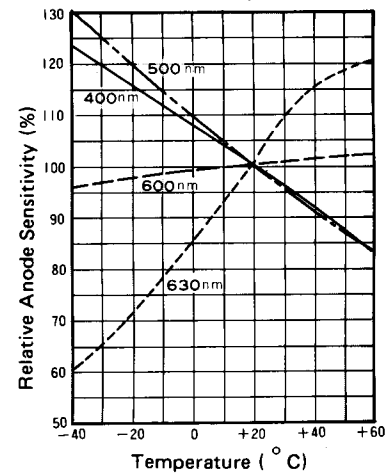
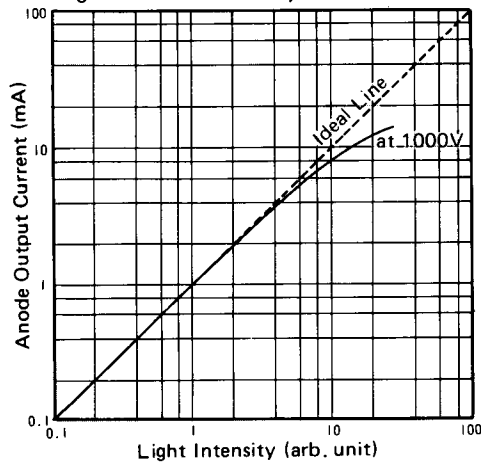
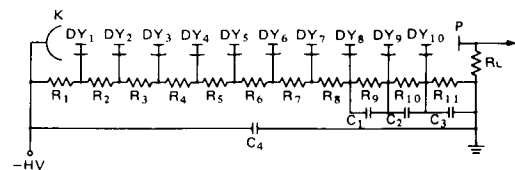


Fig. 6 Pulse Linearity



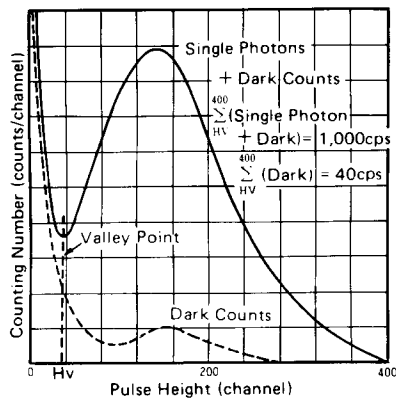
Pulse Width: 50 ns
Duty Ratio: 0.0125 %
Dynode string is as follows;



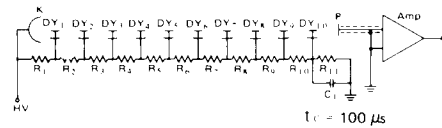
$R_1 = R_{10} = 200 \text{ k}\Omega$
 $R_{11} = 300 \text{ k}\Omega$
 $R_2 \sim R_9 = 100 \text{ k}\Omega$
 $C_1 \sim C_3 = 0.01 \text{ }\mu\text{F}$
 $C_4 = 0.01 \text{ }\mu\text{F (2000 WV)}$

R647 SERIES PHOTOMULTIPLIER TUBES

Fig. 7 Single Photon Response (R647-04)



Incident Number of Photons = 4,300 photons/sec ($\lambda = 420$ nm)
Applied Voltage = 1000V
Ambient Temperature = 20°C
Dynode string is as follows;



$$R_1 \sim R_{11} = 330 \text{ k}\Omega$$

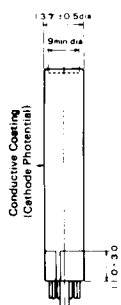
$$C_1 = 0.01 \text{ }\mu\text{F}$$

Fig. 8 Dimensional Outline and Basing Diagrams (Unit : mm)

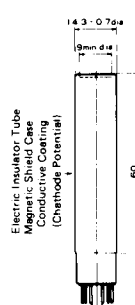
R647, R647-01



R647-02



R647-04



Basing Diagram

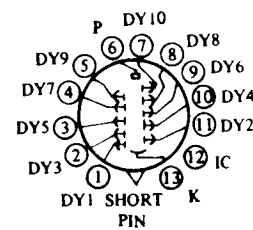
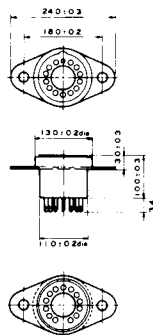
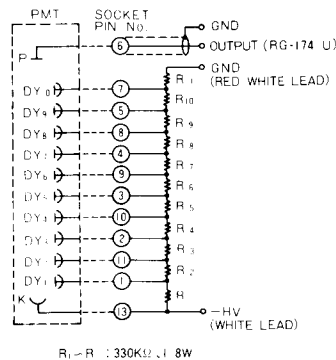
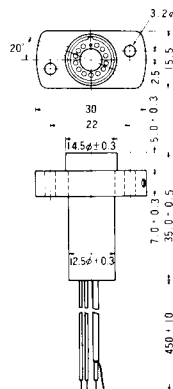


Fig. 9 Accessories

(a) Socket E678-13A
(Furnish with the tube)



(b) Socket Assemblies E849
(Option)



Warning — Personal Safety Hazards
Electrical Shock — Operating voltages applied to this device present a shock hazard.

PHOTON
IS OUR
BUSINESS

HAMAMATSU

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